FLORA W. PATTERSON.

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TWO BARLEY BLIGHTS

L. H. PAMMEL, C. M. KING & A. L. BAKKE

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SUMMARY

1. During the past season there was a widespread disease on barley commonly called rust, but in no way related to this disease. It is caused by an imperfect fungus. There are two forms of these leaf spot diseases of the barley, one an early blight which has been designated as "the yellow leaf disease" and the other "the late barley blight."

2. The yellow leaf disease is caused by the fungus *Helminthosporium gramineum*. This appears earlier during the season and is characterized by yellowish longitudinal stripes alternating with darker lines. This is transmitted by the seed.

3. The late barley blight is caused by the fungus *Helminthosporium sativum*. This fungus causes brown spots of irregular outline, and occurs on the leaves, glumes and seed. The leaves are easily broken up and completely destroyed in some cases. The damage was great. It is the most serious barley disease in Iowa.

4. There are many species of *Helminthosporium* on grasses, one species occurs on the leaves of corn, sometimes doing much injury. Inoculation experiments with the late barley blight failed to produce the disease on corn.

5. The fungus is apparently transmitted with the seed. Not much can be said with reference to treatment. At present we advise formalin treatment the same as for barley smut.

TWO BARLEY BLIGHTS, WITH COMPARISON OF SPECIES OF HELMINTHOSPORIUM UPON CEREALS

L. H. PAMMEL CHARLOTTE M. KING A. L. BAKKE

YELLOW-LEAF DISEASE OF BARLEY

Early in June, 1909, the yellow-leaf disease (*H. gramineum*) was prevalent in some fields of barley at Ames. It appeared just before heading of the grain, and destroyed .50 of one per cent of the barley.

This disease was first recorded* at Ames in 1890. It is characterized by longitudinal yellowish-green spots extending in parallel rows upon the leaves and sheaths. The yellowish-green areas are strongly contrasted to the green of the leaves. All the culms of a single stool are affected, and the diseased plants die prematurely. When the spots of the fungus begin to appear the plant ceases to grow and very little barley is produced. This species was referred to *Helminthosporium gramineum* because it seems to agree with the fungus described by Rabenhorst. It was later found to be somewhat widely disseminated in barley-growing regions. The character of the fungus and its injury to barley were later worked out by several investigators.

Ericksson** of Sweden gives an account of it; and Kirchner† studied it in Germany and gives an excellent detailed description of it. That the fungus is common in Europe appears from the numerous references found in the literature of work by Stonner, Farneti, Diedicke, Noack, Ravn, Rippert, Johnson. It has not, however, been frequently reported in American literature although it must be much more common than the literature would seem to indicate.

*Pammel, L. H. Fungus Diseases of Iowa Forage Plants. Contr. to Monthly Review of Iowa Weather and Crop Service. 2:9. Feb. 1891,
..... Journal of Mycology. 7:36.
..... Bull. Ia. Geol. Survey. 1:209.
2 **Ericksson. Bot. Centbl. 29:89.
3. †Kirchner. Zeitschr. Pflanzenkrank. 1:24.

LATE BARLEY DISEASE

During the latter part of June, 1909, a disease which afterward proved to be very injurious, began to develop upon barley in a field at Ames. The presence of this disease was noted during the same season in South Dakota early in July, and in Minnesota and Saskatchewan also.

It had been observed at Ames in 1907 and 1908, but was not so destructive during those seasons as in 1909.

As published in a note* in 1909, the late disease of barley observed during the past summer is distinct from the yellow-leaf disease.

This new disease manifests itself in the form of brownish circular or somewhat elongated dark-colored spots much the same as in *Piricularia*, soon causing the leaves to become brown. The disease also occurs upon the glumes and spikelets, in some cases even affecting the grain. It has been often referred to as rust. The straw at harvest time has a dull brown color, and instead of standing erect, becomes a tangled mass.

The mycelium consists of branched septate threads in the interior of the leaf; when the grain is affected the mycelium penetrates the starch layer; the fascicled conidiophores break through the epidermis; they are fuscous brown, septate, 8u—10u in width; the divisions sometimes swollen between the septa. Each conidiophore bears a large, cylindrical dark brown spore, with from 7—12 divisions. The spores measure 105—130u by 15—20u.

INJURY FROM EARLY AND LATE BLIGHTS OBSERVED IN THE FIELD

Mr. L. C. Burnett has furnished the following record of observations of the effects of fungi upon twenty-two varieties of barley grown on the Experiment Station barley plots.

The table indicates the amount of smut and of blight present at date of full head. The fungus injury other than smut apparent at this time may be largely attributed to the early blight; also damage by fungus at date of ripening. The date of ripening corresponds with time of full development of the late blight. The injury manifested by the barley at this time may be attrib-

*Pammel, L. H. Breeder's Gazette. July 28, 1909.

uted largely to this disease. The final column showing yield, indicates great falling off on account of diseases.

	Grain Importation	Date Full Head	Smut	Fungus % Affected	Date Ripe	Fungus % Damaged	Lodged	Yield Bu per Acre
Primus	532	7—8	0	98	7—18	100	35	15
Manchuria	170	6—26	0	0	7—16	5	5	34
Kitzing	167	7—9	0	95	7—17	50	50	5
Kitzing	189	7—9	0	95	7—17	50	50	8
Princess	193	7—12	0	100	7—21	100	100	5
Princess	529	7—12	0	100	7—21	100	100	7
Hanna	203	7—1	2	20	16	90	100	19
Hannchen	531			Dead	16	100	100	
Oderbruch	537	6—30	0	0	16	T	80	33
Chevalier	200	7—12	0	100	16	0	0	7
Bohmes' Beardless	507	6—25	2	T	12	2	95	22
Little Hulless	335	7—3	T	T	11	1	40	14
Hulless	22	6—27	0	T	6	4	95	8
Black Hulless	596	6—28	0	T	10	3	85	26
Hulless	598	6—27	T	T	6	3	90	11
Colorado Hulless	475	6—27	0	T	7	4	95	9
Hulless	629	6—27	0	T	7	4	100	19
White Hulless	424	6—29	0	15	11	T	100	12
Bohmes'	533	6—28	0	5	8	4	100	11
Del Notre	630	6—28	0	T	6	3	95	13
Sangatsuka	78	6—27	0	5	9	3	60	25
Arpa	528	6—26	10	10	4	5	95	9

NOTE: The damage seems to be twofold with the common barleys. Not only are the plants weakened in producing power, but the straw is decayed to such an extent that it lies flat on the ground, and does not fill. The odor from this rotten straw is very similar to that from rotting potatoes.

CULTURES AND INFECTION EXPERIMENTS

It was not difficult to get pure cultures of the organism by placing diseased leaves in sterile petri dishes containing agar with some extract from barley leaves.

In cultures the spores develop much more slowly than upon diseased leaves placed in moist petri dishes.

Infection experiments were subsequently made with the barley plant, from pure cultures. For this purpose the barley was allowed to germinate, and the young plants were inoculated by sprinkling with spores, and by inoculating the soil with spores. In the course of two weeks, when the plants were about four inches in height, yellowish spots appeared upon the leaves. It was found that at the point of inoculation, the fungus had penetrated the epidermis.

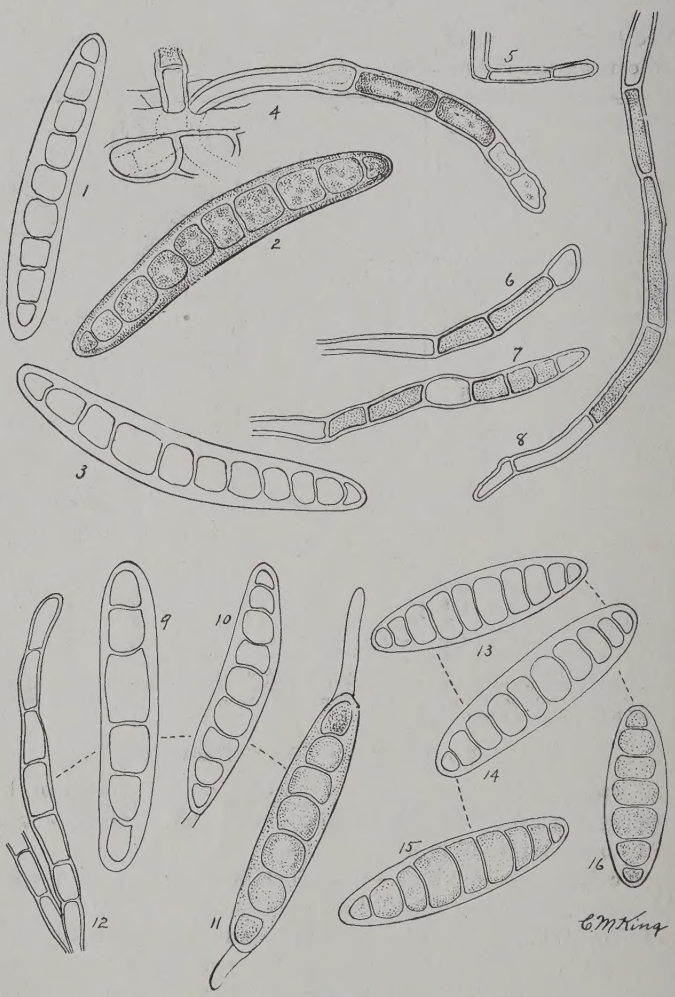


PLATE I

Helminthosporium sativum from barley in field. 1, 2, 3 spores; 5, 6, 7, 8 conidiophores

Helminthosporium on *Festuca pratensis*. 9, 10 spores; 11 germinating spore; 12 conidiophore

Helminthosporium on barley in greenhouse. Transferred from *Helminthosporium sativum* on barley in field, 13, 14, 15, 16 spores

We had no difficulty last fall in producing positive infection results by use of dried specimens affected by the *Helminthosporium*. It would seem therefore, that the seed may sometimes be the source of infection, both of this disease, and of the yellow-leaf disease of barley.

CROSS INOCULATION EXPERIMENTS

An experiment was made in the field, to determine whether the *Helminthosporium* growing upon barley may infect corn. The results were wholly negative.

The fungus under consideration was submitted to Saccardo for examination, who reported it more like *H. teres* than like *H. gramineum*.

Cultures alone will conclusively determine whether *H. sativum* and *H. teres* are identical. Morphologically the two are closely related, but provisionally a separate name may be given to the new barley disease.

THE DESCRIBED DISEASES UPON BARLEY DISTINCT FROM SPECIES OF HELMINTHOSPORIUM UPON CORN

Several other species of *Helminthosporium* are recorded upon cereals; one *H. turcicum* described by Passerini, occurs upon corn. Stewart* subsequently described a disease found seriously affecting sweet and field corn on Long Island referring it to *H. inconspicuum*. The same has been reported by Thaxter on sweet corn in Connecticut in 1889. Ellis**, to whom the specimen of yellow-leaf disease on barley was submitted at the time of its first observation in Iowa, pronounced it *H. gramineum*, and identical with *H. turcicum*. In a later publication the opinion was stated that the fungi are different; also that the Italian fungus (*H. turcicum*) has not been observed here.

Regarding the identity of *H. turcicum*, with *H. gramineum*, Comes† holds them distinct, although closely related. Subsequently C. O. Smith states the opinion that the American fungus (*H. inconspicuum*) is probably identical with the *H. turcicum* of Italy.

Farneti††, who studied the various species of *Helminthospor-*

*F. C. Stewart. Rep. Geneva N. Y. Agr. Exp. Sta. 15:452.
**Pammel, L. H. Bull. Ia. Geol. Surv. 1:213.
†Pammel. L. H. Bull. Ia. Geol. Surv. 1:210.
††Crittogamia Agraria. 409.

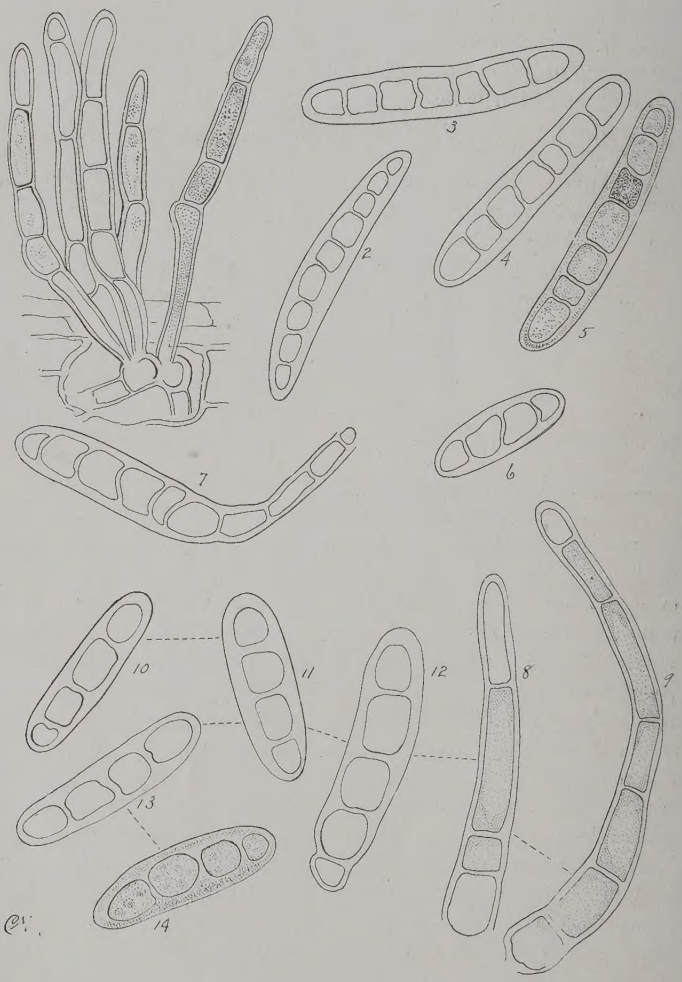


PLATE II

Helminthosporium gramineum. 1, conidiophore; 2, 3, 4, 5, 6 spores; 7 spore attached

Helminthosporium teres. 8, 9 conidiophores; 10, 11, 12, 13, 14 spores

ium occurring on oats and barley (*H. Avenae* on oats and *H. teres* on barley) found that the species on oats gave few infections on barley, and none upon other cereals, and that the barley species infected only the barley plant.

LIFE HISTORY OF SPECIES OF HELMINTHOSPORIUM

A number of European writers have studied the life history of the *H. gramineum* and other species. Diedicke* discusses *Pleospara trichostoma* as the perithecial form of *H. gramineum*. Noack** agrees with Diedicke in this opinion. Johnson† calls attention to *H. gramineum* and to its ascospore stage in Ireland. Farneti†† from his own studies concludes that *Piricularia grisea, P. oryzae, Helminthosporium oryzae,* and *H. turcicum* are different forms of one species. This seems hardly probable.

SPECIES OF HELMINTHOSPORIUM FOUND UPON GRAMINEAE

The genus is not uncommon upon various members of the gramineae, Saccardo in Sylloge Fungorum records the following species:

H. teres Sacc. (*Hordeum sativum* Italy); *H. gramineum* Rabb. (*Hordeum vulgare* Germany); *H. avenae* Oud. (*Avena sativa* Holland); *H. avenaceum* Curtis (*"in stramine avenaceo"* N. Am.); *H. Sorokinianum* Sacc. (*Triticum* and *Secale* Russia); *H. tritici* P. Henn. (*Triticum vulgare* Africa); *H. inconspicuum* Cano Ell. (*Zea mays* New Jersey); *H. turcicum* Pass. (*Sorghum vulgare* and *Zea mays* New Jersey); *H. Sorghi* Schw. (*Sorghum* N. Am.); *H. Euchlaenae* Zimm (*Euchlaena mexicana* Africa); *H. sigmoideum* Cav. (*Oryza sativa* Italy); *H. foveolatum* Pat. (*Bambusae* Tonkin); *H. coaguazuense* Speg. (*Bambusae* Brazil); *H. Bambusae* Cooke (*Bambusae* Assam); *H. rhapaloides* Fres. Sacc. *forma Bambusae* P. Brun. (*Bambusae arundinacea* France) *H. Ravenelii* Curtis et Berk. (*Sporobolus* Carolina and Cuba); *H. Tonkinense* Karst. et Roum. (*Sporobolus tenacissimus* Tonkin); *H. crustaceum* P. Henn. (*Sporobolus* Java); *H. nodulosum* B. & C. (*Eleusine Indica* N. Am.); *H. viticulosum* Cr. (*Phragmites communis* France) *H. fugax* Wallr. (*Agrostis spica-venta*); *H. Leer-*

*Diedicke, H. Centbl. Bakt. u. Par. 2 Abt. 11:52-59. 1903.
**Noack, F. Ztschr. Pflanzenkrank. 15:193-205, pl. 1. 1905.
†Johnson, T. Econ. Proc. Roy. Dublin Soc. 1:345-370. 1907.
††Farneti, R. Riv. Patol. Veg. 2:1-11; 17-42. 1906.

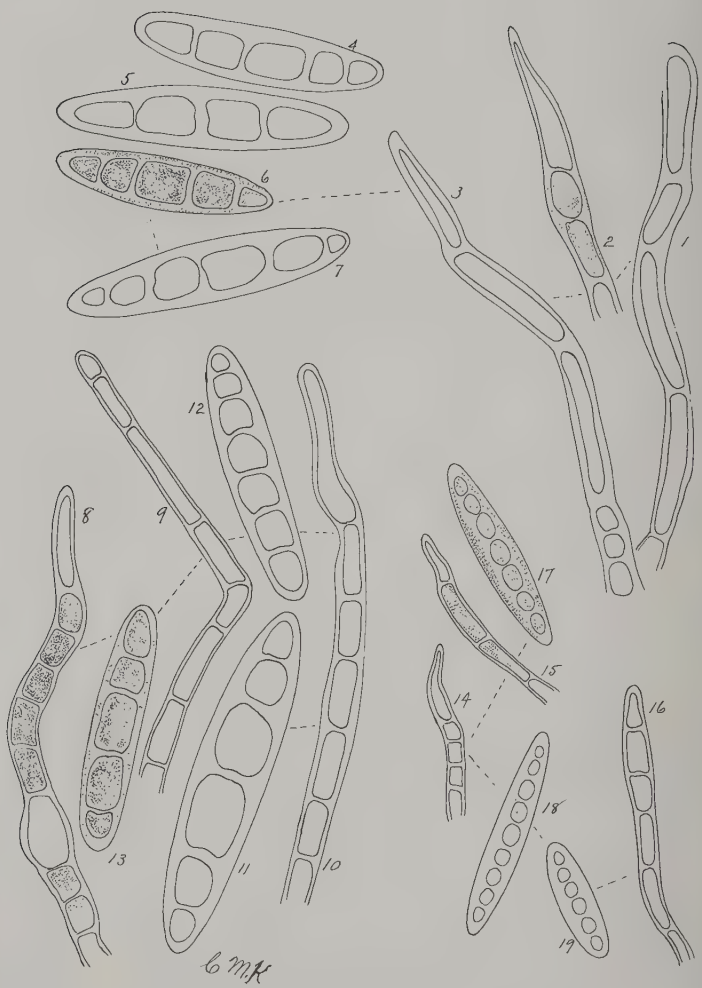


PLATE III

Helminthosporium inconspicuum. 1, 2, 3 conidiophores; 4, 5, 6 spores
Helminthosporium turcicum. 8, 9, 10 conidiophores; 11, 12, 13 spores
Helminthosporium inconspicuum var *Buchloes.* 14, 15, 16 conidiophores; 17, 18, 19 spores, showing thick walls

sia Atk. (*Leersia virginica* Ala.); *H. flagelloideum* Atk. (*Panici* Ala.); *H. geniculatum* Tracy and Earle (*Eragrostis rachitricha*); *H. hadrotrichoides* Ell. & Ev. (*Eragrostis major* Faulkland, Del. N. Am.); *H. parvulum* Cke. (*Gynerium argenteum* New England); *H. inconspicuum* var. *brittanicum* Grove (Grasses England); *H. graminis* McAlp. (*Ammophila arundinaceae* Australia). Here also may be noted *H. teres* forma *avenae sativae* (Exsiccati Briosi and Cavara Italy); *H. inconspicuum* C. & E. var. *Buch. loes* Ell. and Ev. (Exsiccati Ellis & Everhart) *Buchloe dactyloides*, Kansas. Reed distributed *H. inconspicuum* from Virginia; spores from this specimen are very thin-walled.

We collected on *Festuca pratensis* in fields near the barley, a fungus apparently identical with the late disease of barley. The spores, however, are smaller, although of the same shape. The leaf was not so abundantly spotted.

An English writer reports *H. gramineum* Rabh. on *Hordeum sativum* and on wild species of barley.

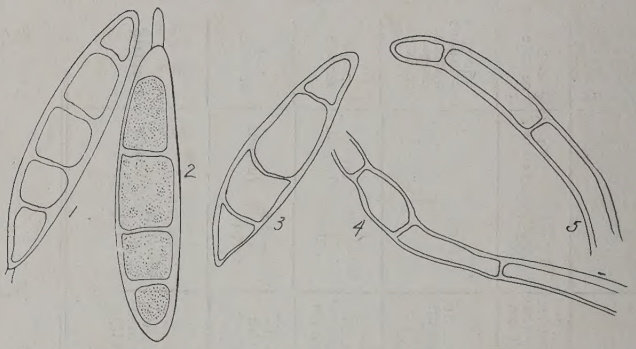
TREATMENT

Not much can be said at this time in regard to the treatment for the disease. Infection experiments have shown that the seed carries the fungus over from one season to another. It is probable that treating the seed with formaldehyde at the rate of 1 pound to 40-50 gallons of water will be efficacious in destroying the spores on the surface.

Table of Comparison of Characters of Various Species of *Helminthosporium* upon Cereals

Name of Fungus	Host	Habitat	Appearance on host	Sporophore				Spore			
				Arrangement	Size	Color	Other characters	Shape	Size	Color	Cells
H. sativum n. sp.	Hordeum sativum	Iowa	Irregular dark greenish-brown spots	fascicled	150u—180u x 6u—10u	Smoky reddish brown dark	somewhat flexed; tip blunt, pale; septate	Straight or curved slender widest at middle	105u —130u x 15u—20u	Pale greenish gray	7—14
H. teres Sacc.	Hordeum sativum	Italy	Oblong spots on either surface; dusky green	fascicled	110u—120u x 12u	dark brown	thickened at base sometimes	acrogenous rounded on sides cylindrical	100u—115u x 18u	pale dark-green greenish brown to straw	4—5 divided but not constricted
H. graminicum Rabh.	Hordeum vulgare	Germany	slightly effuse on surface of leaf	fascicled	100u—120u x 6u—10u	pale gray	slightly bent	elongate cylindrical	75u—95u x 15u—17u	pale greenish gray to straw color	3—6 divided
H. turcicum Pass	Sorghum vulgare and Zea Mays	Italy	very dry spots on leaf	clustered	150u—6u	pale greenish brown	3-septate nearly straight blunt tip pale	fusiform epispore swollen	85u - 92u x 20u—24u	olive brown	5—8 septate
H. inconspicuum C. and Ell.	Zea Mays	N. J. and Conn.	slender spreading markings		60u—140u x 7u—9u	very pale brown	septate swollen spaces between septa	slender somewhat pointed	80u—120u x 20u	pale olive-gray to yellowish	3—6 septate
H. inconspicuum varbrittanicum Grove.	"various grasses"	England	spreading brown markings		160u—180u x 10u	pale brown	somewhat flexed 4—5 septate	oblong	60u—100u x 18u—22u	pale	4—5 septate

H. sorghi Schw.	Sorghum	N. Am.	tufts in minute narrow dark lines	"dense"		dark	simple erect subacuminate septate				
H. avenaceum Curtis	"in stramine avenaceo"	N. Am.	effuse velvety dark markings			somewhat opaque	septate erect	nearly cylindrical somewhat fusiform	75u—85u x 15u	pale yellow	4—5 septate
H. Avenae Oud.	Avena	Holland	wide fuscous spots with black tufts in series of rows	fascicled	175u—200u	smoky	simple swollen at bended joints	straight elliptical			young continuous mature once—septate
H. Sorokinianum Sacc.	Triticum and Secale	Russia	tufts floccose tawny brown		long	brown	bent septate	ovate straight or curved fusiform	80u—100u x 30u	tawny brown	5—10 septate
H. Tritici P. Henn	Triticum	Afr.	tufts powdery then crust-like dark-green	fascicled	3½u—5u wide	fuscous	septate some divisions swollen	tipped with point oblong fusiform	12u—25u x 4ux7u	fuscous	2—4 septate
H. Euchlaena Zimm.	Euchlaena mexicana	Afr.	elongate brownish spots with darker margin mm 20-22 mm X2 mm	tufted group of 1 to 3	150u x 5u—7u		simple septate	straight or curved pointed at tip	50u—60u x 13u—15u	brown	7 septate



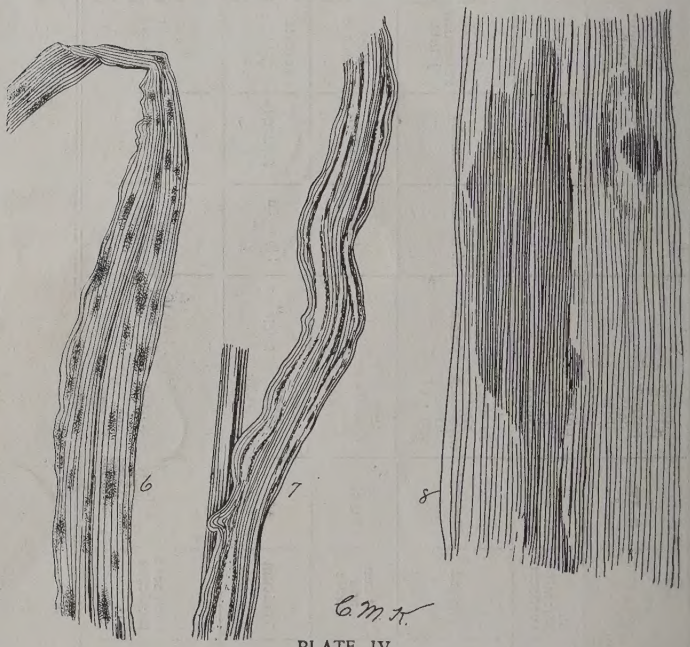


PLATE IV

Helminthosporium inconspicuum. (Specimen from Virginia, sent by Reed) 1, 2, 3 Spores; 4, 5 conidiophores
Leaf of Barley affected by *Helminthosporium sativum n. sp.* 6
Leaf of Barley affected by *Helminthosporium gramineum.* 7
Leaf of Corn affected by *Helminthosporium inconspicuum.* 8